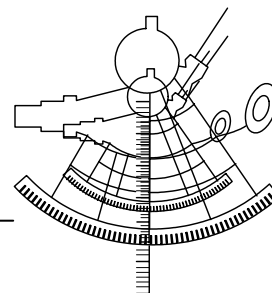


European Trend Chart on Innovation



2003 European Innovation Scoreboard: Technical Paper No 5 National Innovation System Indicators

October 31, 2003



The European Trend Chart on Innovation

Innovation is a priority of all Member States and of the European Commission. Throughout Europe, hundreds of policy measures and support schemes aimed at innovation have been implemented or are under preparation. The diversity of these measures and schemes reflects the diversity of the framework conditions, cultural preferences and political priorities in the Member States. The 'First Action Plan for Innovation in Europe', launched by the European Commission in 1996, provided for the first time a common analytical and political framework for innovation policy in Europe.

Building upon the Action Plan, the *Trend Chart on Innovation in Europe* is a practical tool for innovation policy makers and scheme managers in Europe. Run by the European Commission (Innovation Directorate of DG Enterprise), it pursues the collection, regular updating and analysis of information on innovation policies at national and Community level, with a focus on innovation finance; setting up and developing innovative businesses; the protection of intellectual property rights; and the transfer of technology between research and industry.

The Trend Chart serves the "open policy co-ordination approach" laid down by the Lisbon Council in March 2000. It delivers summarised and concise information and statistics on innovation policies, performances and trends in the European Union. It is also a European forum for benchmarking and the exchange of good practices in the area of innovation policy.

The Trend Chart products

The Trend Chart on Innovation has been running since January 2000. It tracks innovation policy developments in all EU Member States, plus Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Iceland, Israel, Latvia, Lithuania, Norway, Poland, Romania, Slovak Republic, Slovenia and Switzerland. The Trend Chart website (www.cordis.lu/trendchart) provides access to the following services and publications:

- the European Innovation Scoreboard and other statistical reports;
- regular country reports for all countries covered;
- a database of policy measures across Europe;
- a "who is who?" of agencies and government departments involved in innovation;
- regular trend reports covering each of the four main themes;
- benchmarking reports from the Trend Chart workshops;
- a news service and thematic papers;
- the annual reports of the Trend Chart.

The present report was prepared by **Anthony Arundel** of MERIT (www.merit.unimaas.nl). The information contained in this report has not been validated in detail by either the Member States or the European Commission.

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European Innovation Scoreboard

The European Innovation Scoreboard (EIS) was developed at the request of the Lisbon European Council in 2000¹. It focuses on high-tech innovation and provides indicators for tracking the EU's progress towards the Lisbon goal of becoming the most competitive and dynamic knowledge-based economy in the world within the next decade.

The 2003 EIS contains 19 main indicators, selected to summarize the main drivers and outputs of innovation. These indicators are divided into four groups: Human resources for innovation (5 indicators); the Creation of new knowledge (4 indicators); the Transmission and application of knowledge (3 indicators); and Innovation finance, output and markets (7 indicators).

The EIS complements the *Enterprise Policy Scoreboard*² and other benchmarking exercises of the European Commission. It mainly uses Eurostat data. Six indicators are drawn from the European Commission's Structural indicators. Eight indicators are also used by DG Research under the "Investing in Research" Action Plan for Europe³.

All indicators have been updated based on data availability as of September 23, 2003. The 2003 EIS offers a number of improvements compared to the 2002 EIS. Most importantly, it will use new and more detailed data from the 3rd Community Innovation Survey (CIS-3). It provides a substantially improved coverage of innovation in services. A supplementary technical report, the *Sectoral Innovation Scoreboard* (SIS), replicates the EIS, where possible, for four manufacturing classes: high medium-high, medium-low, and low technology. The background national context that influences innovation performances across the 15 EU member states is described in a second supplementary report on *National Innovation Systems* (NIS).

The EIS is complemented by six technical papers:

- Technical Paper No 1: Indicators and definitions
Full definitions and graphs for all indicators.
- Technical Paper No 2: Analysis of national performances
Detailed EIS results for current and trend data, innovation leaders, relative strengths and weaknesses per country, and country pages with both current and trend graphs.
- Technical Paper No 3: Regional innovation performances
Detailed results for current data, innovation leaders, a revealed regional summary innovation index, and cluster analysis for 173 regions in 13 Member States using 13 regional innovation indicators.
- Technical Paper No 4: Sectoral Innovation Scoreboards
Replicates the EIS for four classes of manufacturing sectors.
- Technical Paper No 5: National Innovation System Indicators
Includes nine structural and 14 socio-cultural-institutional indicators that shape the background conditions for innovative activity in each EU Member State.
- Technical Paper No 6: Methodology report
Describes the methodology underlying the EIS, including different methods for calculating a Summary Innovation Index.

All technical papers are available from the Trend Chart website (www.cordis.lu/trendchart).

¹ A first provisional EIS was published in September 2000: COM(2000) 567. The first full version of the EIS was published in October 2001: SEC(2001) 1414. The second full version was published in December 2002: SEC(2002) 1349.

² SEC(2002) 1213.

³ SEC(2003) 489.

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SUMMARY

The European Innovation Scoreboard (EIS) provides national and European policy makers with a guide to changes in innovative capabilities over time, in order to assess progress towards the goal of making Europe the most competitive knowledge based economy by 2010. However, policy makers need to know not only *how* innovative capabilities are changing over time, but the factors that *influence* these changes. These include both the policy environment and the national innovation system (NIS) within each country.

Each NIS contains two major features that influence innovative capabilities. The first consists of structural, economic characteristics, such as the economic weight of SMEs within the economy, the distribution of economic activity by sector, and demand for innovations. The second feature includes socio-cultural and institutional conditions that encourage individuals, entrepreneurs, and employees to actively look for opportunities for innovation. Both features of an NIS will partly determine the innovative capabilities of a country.

This report explores the links between structural and socio-cultural-institutional (SCI) aspects of an NIS and innovation. We obtained structural and SCI indicators for the 15 current Member States of the European Union from a range of sources, including Eurostat, the OECD, and European Commission documents. We identify three categories of structural indicators; demand for innovative products, industry structure, and openness to trade; and six categories of SCI indicators: the financial system, receptiveness to new ideas, social equity, the labour market system, entrepreneurial attitudes, and social capital. In total, there are 9 structural and 14 SCI indicators.

The EIS assumes that innovative performance increases with the value of each indicator, such as national patenting rates and R&D investment. In contrast, there is no ‘better or worse’ value for many of the structural and SCI indicators. Consequently, we do not construct a summary NIS index. Instead, we explore two research questions:

1. Can we identify groups of countries that are similar across the structural and SCI indicators, or more specifically, can we identify clusters of National Innovation Systems?
2. Are any of the structural and NIS indicators correlated with measures of national innovativeness?

Our analyses show that there are two distinctive NIS clusters among the 15 EU Member States, plus two additional clusters that are not as clearly defined. The two distinctive clusters consist of four countries (Greece, Portugal, Spain and Italy) dominated by low-tech SMEs and four countries with high social equity (Sweden, Denmark, Finland, and the Netherlands). The low-tech SME cluster has below average scores on many indicators, except for a high score for entrepreneurship. The equitable society countries have high scores on social equity, receptiveness to new ideas, trade union membership, and trust. Within Europe, the low tech SME cluster has the lowest scores on per capita GDP and innovativeness (as measured by the 2003 EIS summary innovation index), while the equitable societies cluster has the highest scores on innovativeness and similar per capita GDP rates as the rest of Europe, outside of the low tech SME cluster.

The remaining two clusters are less well defined. They consist of a cluster of three countries (Austria, Belgium and Germany) with average values on many indicators but with a very low preference for entrepreneurship, and a cluster consisting of France and the UK. The latter share several ‘market-solution’ approaches, with low rates of social trust and union membership but high rates of market financing, private services, and entrepreneurship. Of note, Ireland and Luxembourg could not be included in the cluster analyses due to missing data.

Several NIS indicators that are commonly believed to be important factors in innovation had no effect or only a weak positive effect in this study: economic openness of the economy, a market based finance system, domestic demand for innovative products, and receptiveness to new ideas. The largest effect is negative and includes the SME employment share and the percentage of manufacturing value-added due to low and medium-low technology manufacturing. A striking result of these analyses is the strong correlation between social equity and innovation. However, it is difficult to know if this relationship is causal or an artifact. Nevertheless, high social equity clearly does not interfere with either high GDP per capita or with high innovative capabilities at the national level – at least within the EU.

The greatest policy challenge for Europe in terms of innovation is to shift the innovative capabilities of the low-tech SME countries upwards. The analyses in this paper suggest that this could require both a structural shift from SMEs to larger firms and a shift from low technology to medium and high technology manufacturing.

1. Introduction

The European Innovation Scoreboard (EIS) measures the innovative performance of EU countries using 20 indicators that measure four main aspects of the innovation process: human resources, the creation of new knowledge, the transmission and application of knowledge, and, finally, innovation finance, outputs and markets. Although both creative, R&D based innovation and adoptive, diffusion based innovation are included in the EIS, the focus of the EIS is on R&D based innovation in high technology sectors.

The function of the EIS is to provide national and European policy makers with a guide to changes in innovative capabilities over time, in order to assess progress towards the goal of making Europe the most competitive knowledge-based economy by 2010. For this reason, the EIS includes trend analyses for each indicator. However, policy makers need to know not only *how* innovative capabilities are changing over time, but the factors that *influence* these changes. These include both the policy environment and the national innovation system (NIS) within each country.

The national TrendChart policy documents provide in-depth evaluations of national policies of relevance to innovation. The remaining gap in the TrendChart coverage of influences on national innovative capabilities concerns how each NIS shapes current innovative capabilities. Why is it, for example, that the area around Cambridge has become an incubator for biotechnology innovation and the area around Helsinki is a world leader in mobile communications, while ‘innovation’ is rarely associated with other European cities such as Palermo, Athens, Rome, Bordeaux, Liverpool or Amsterdam? The purpose of this report is to try to identify the factors that produce such differences in innovative capabilities within Europe, albeit at the national level.

Each NIS contains two major features that influence innovative capabilities. The first consists of structural, economic characteristics, such as the economic weight of SMEs within the economy and the distribution of economic activity by sector. Countries that specialize in high technology manufacturing, such as telecom equipment or pharmaceuticals, will perform better on the EIS than countries that specialize in food processing and textiles. This is because much of the value-added produced by high technology firms is based on R&D – in effect, R&D is the product that is purchased by the end user. Conversely, the value-added in food or textile products is due to other factors, such as the quality, safety and efficiency of manufacturing processes or design features. Many of these features will depend on investment in innovative equipment or the imagination of staff, but these characteristics are not fully captured by the EIS.

One option for innovation policy is to encourage an economic shift from low and medium technology sectors towards high technology sectors. Although part of the solution, there are economic limits to this strategy because the market for high technology products (even globally) simply is not large enough to support a Nokia or a Glaxo-SmithKline-Wellcome in every country of the European Union. Instead, policy should also encourage low and medium technology manufacturers, plus service sector firms, to reach an optimum level of innovative capacity.

The second major feature that influences innovative capabilities is much more difficult to define, but includes socio-cultural and institutional conditions that encourage individuals,

entrepreneurs and employees to actively look for opportunities for innovation, and to acquire the tools to successfully implement them. Both features of a NIS, the structural and socio-cultural-institutional conditions, will partly determine the innovation trajectory open to a country.

This document identifies and discusses key structural indicators, develops indicators for socio-cultural-institutional (SCI) factors, and explores the relationship between both sets of indicators and national innovative capabilities. The evaluation of SCI indicators is primarily exploratory. We include SCI indicators that other research suggests *may* form the socio-cultural and institutional framework for innovation.

Recent research has begun to look closely at these SCI factors. As an example, Coriat and Weinstein (2002) stress that the institutional characteristics of an economy will influence both the modes of innovation at the firm level, and the importance that firms give to innovation as a competitive strategy. These institutions include both ‘the rules, habits and customs that define patterns of behaviour and shape human interaction’, many of which are difficult to measure, and ‘the system of industrial relations, the financial system, the state structure, the forms of competition and the modes of inter-firm relationships’.

These formal and informal rules, behaviours and institutions, in combination with different histories, natural endowments and social structures, lead to what Hall and Soskice (2001) define as ‘different varieties of capitalism’. These varieties of capitalism can result in specific modes of innovation that are partly due to different methods of financing innovation, different labour relations systems, (Rutherford, 2003) or different styles of innovation. Breschi et al (2000) provide evidence showing that some industrial sectors focus on a *widening* pattern of innovation characterized by radical innovation and new entrants, while other sectors focus on a *deepening* pattern with incremental innovation by existing firms⁴. For historical and institutional reasons, countries can develop strengths in one or the other mode of innovation, which can partially determine the industrial structure of the country (Coriat and Weinstein, 2002).

As shown below, some of the available SCI indicators do not correlate with national innovative capabilities, while other indicators show a strong relationship with EIS indicators of innovative capability.

2. Methodology

We obtained structural and SCI indicators for the 15 current Member States of the European Union from a range of sources, including Eurostat, the OECD, European Commission documents, UNCTAD, and the published literature. We did not obtain indicators for the US, Japan or the Acceding countries because of missing data and because this work is exploratory. Some of the structural and SCI indicators used here have also been used in other European Commission reports, as summarized in Annex Table A1.

⁴ It would be of interest to have a measure of this mode of innovation for all EU countries. However, the authors were only able to acquire the necessary data for three EU countries; the UK, Italy, and Germany.

The primary problem is to obtain SCI indicators, since many of the key concepts, such as social creativity and social capital, are difficult to define and measure accurately. Consequently, many of our indicators are, more accurately, proxy measures of underlying phenomenon.

We identify three categories of structural indicators; demand for innovative products, industry structure, and openness to trade; and six categories of SCI indicators: the financial system, social creativity (more accurately exposure or receptiveness to new ideas), social equity, the labour market system, entrepreneurial attitudes, and social capital. In total, there are 10 structural and 14 SCI indicators.

The EIS assumes that innovative performance increases with the value of each indicator, such as national patenting rates and R&D investment. In contrast, **there is no ‘better or worse’ value for many of the structural and SCI indicators.** Although we can assume that higher per capital GDP is a worthwhile policy goal, we cannot assume that there is an optimal industrial distribution or that one financial or industrial relations system is preferable to another. Different varieties of capitalism or modes of innovation could be equally effective. These limitations mean that we cannot combine many of the indicators into a composite index, as used in the EIS. However, we believe that the indicators for two Structural categories (domestic demand and openness) and three SCI categories (social equity, receptiveness to new ideas, and entrepreneurial attitudes) can be used to create composite indices.

The structural and SCI indicators measure long-term structural conditions, attitudes and social institutions that change relatively slowly over time. Wherever possible, we adjust for yearly variations, possibly due to sampling variation, by taking the average of several years of data.

2.1 Research questions

Since there is no ‘better or worse’ value for many of the indicators, it does not make sense to create a scoreboard of NIS indicators, although for reference we provide the original data for all indicators by country in Annex Table A2. Instead, we focus on two goals:

1. Are any of the structural and NIS indicators correlated with measures of national innovativeness? In order to explore this question, we correlate these indicators with seven key innovation indicators drawn from the EIS⁵ (the percentage of the working age population with a tertiary education, employment in high tech services, business R&D intensity, high technology EPO patents, percent of manufacturing SMEs involved in innovation cooperation, early-stage venture capital supply, and the share of innovative products in total manufacturing sales), and with the EIS 2003 summary innovation index (SII).
2. Can we identify groups of countries that are similar across the structural and SCI indicators, or more specifically, can we identify clusters of National Innovation Systems? This question goes to the heart of different modes of innovation. These will depend, in part, on the structure of national economies and socio-cultural and institutional factors.

⁵ The key indicators are drawn from each of the four EIS categories and capture a substantial percentage of the variation among the indicators within each category.

Many of the graphs and tables do not present the original values for each indicator (as shown in Table A) but use percentage differences from the EU mean. The values based on the percentage difference from the EU mean are also used to construct the five composite indices for demand, openness, social equity, receptiveness to new ideas, and entrepreneurship. The composite indices are the averages of the percentage differences and are then adjusted so that the EU mean equals 100.

The cluster analyses, in contrast, are based on rescaled values because of the requirement to use data of the same dimensions and within a limited range of values. We therefore rescale each indicator using the following method:

$$1) \quad y_{ij}^t = \frac{x_{ij}^t - \min(x_j^t)}{\text{range}(x_j^t)}$$

Where x_{ij}^t is the value of indicator j for country i at time t , the minimum value of x_j equals the minimum observed value within the dataset, and the range equals the difference between the minimum and maximum observed values. All rescaled indicators vary between zero and 1, with zero equal to the lowest observed value and 1 equal to the highest observed value. The rescaled values for each indicator are given in Table A3.

Cluster analysis results are given in Tables 3.3, 4.1, and 5.1. The value for each cluster and indicator (for example the value of 0.20 in Table 3.3 for cluster 1 for OPEN) equals the average rescaled score for the indicator among the countries in the cluster. In this example, the score of 0.20 for OPEN indicates that the four countries in this cluster have OPEN scores that are close to the lowest observed score in the EU, which is set equal to 0.

3. Structural economic indicators for innovation

Table 3.1 describes each structural economic indicator and lists the data source and dates.

Table 3.1 Structural indicators

Categories	Source	Year
1 Demand potential for innovations		
1.1 GDP per capita in PPS, relative to the EU-15 average of 100	Eurostat: Structural indicator a1.	Average 1998-2002
1.2 Youth share: Ratio of the share of the total population under 30 to the share 65 and over	Eurostat: Demography statistics	2000
1.3 Average time to sales takeoff for consumer products	Tellis et al, 2003, Table 2A	1950-1994
1.4 Capital investment (Gross fixed capital formation by the private sector as a percentage of GDP)	Eurostat: Structural indicator III.7	Average 1997- 2001
2 Industry structure		
2.1 Percent of all private sector value added (primary, manufacturing & services) from private services.	OECD (STAN)	Average 1997- 2001
2.2 Percent of all manufacturing value-added from low & med-low technology manufacturing.	OECD (STAN)	Average 1995- 1999
2.3 SME share of total manufacturing employment	Eurostat: Business in Europe, Statistical Pocketbook	Average 1995-2000
3 Open economy		
3.1 Transnationality Index for 2000 (average of FDI inflows as a percent of gross fixed capital formation 1998-2000, FDI inward stock as a percent of 2000 GDP, value added of foreign affiliates as a percent of GDP in 2000, and employment of foreign affiliates as a percent of total 2000 employment)	UNCTAD, World Investment Report 2003	1998-2000
3.2 Trade openness: Imports + exports of goods and services divided by GDP.	Eurostat: Structural indicators III.6.4 and III.6.5	Average 1997-2001
3.3 Foreign-funded R&D as a percentage of total R&D	Eurostat: Structural indicator II.2.4	Average 1995-1999

Notes: Eurostat structural indicators are available at europa.eu.int/comm.

3.1 Demand potential for innovative products

Firms need markets for their innovative products. There are two main markets – business investment in new capital equipment, including Advanced Manufacturing Technology and ICT, and consumer demand for final products. Porter's (1990) "diamond" of competitive advantages includes sophisticated domestic demand as an important component of innovative capability because of the role that informed consumers can play in demanding technically

advanced, innovative products⁶. Of course, firms can export innovative products to demanding consumers in other countries, but this will increase the transaction costs of acquiring consumer feedback.

We lack direct indicators for ‘sophisticated consumer demand’ and must therefore turn to four proxy indicators. Research consistently shows that the adoption rates for innovative consumer products and services, such as mobile telephones and internet access, is inversely proportional to age and positively correlated with income. As an example, in 2000, 90% of Italian between the age of 15 and 24 had a mobile phone, compared to only 30% of Italians over the age of 55 (EURESCOM, 2001). Two of our proxies for consumer demand for innovative products are therefore per capita GDP (in purchasing power standards (PPS))⁷ and the youth share of the population, or the ratio of the total population under 30 to that 65 and over.

The third proxy for consumer demand is possibly closer to what we would like measure. Tellis *et al* (2003) determined the average time between product introduction on a national market and sales take-off (the time when the rate of sales growth rapidly increases) for up to 10 consumer products. The shorter the sales take-off time, the more consumers are interested in purchasing innovative products. The authors find that cultural factors have a significant effect on the time to take-off, but this could also be due to a positive correlation between their cultural measures and economic factors. The main disadvantage of their data is that it is out of date – referring to product introductions between 1950 and the 1990s.

Our fourth demand indicator is a proxy for business investment in innovations. Unfortunately, there are no consistent indicators across the EU that are limited to investment in AMT, ICT or other innovative capital equipment. Consequently, we use gross fixed capital formation (GFCF) by the private sector as a percentage of GDP, even though this indicator includes investment in buildings and other capital stock that may or may not be innovative⁸.

3.2 Industry structure

As noted in the introduction, there are different “modes of innovation” that are closely linked to sectors of economic activity. Two basic modes are the creation of innovations, via R&D, and the adoption of innovations. Pavitt’s (1984) seminal work in this area identified several innovation modes in manufacturing that were linked to the sector of activity. As an example, he identified ‘science-based’ sectors, such as pharmaceuticals, where innovation is based on research close to the knowledge frontier, and ‘supplier-dominated’ sectors where firms mostly innovate by adopting new software, machinery, and equipment produced by other firms. The choice to innovate via R&D or adoption will be influenced by technological opportunities in the firm’s sector, appropriation conditions, and demand.

Since not all economic sectors contribute in the same way to innovation, measures of a country’s innovative capacity based on creative or R&D-based innovation will be strongly influenced by the nation’s sectoral composition. A country with a large high-technology

⁶ Biese (2001) looks at the same issue in Europe in an evaluation of the mobile telecom equipment sector.

⁷ Similarly, Furman *et al.* (2002) use GDP per capita to measure the ‘ability of a country to translate its knowledge stock into a realized state of economic development’, which assumes that income plays a role in the economic realization of inventions – or innovation.

⁸ New buildings can include innovative design elements that improve productivity, such as multiplex cinemas that permit one projectionist to manage several films simultaneously.

sector will show a higher innovation performance than a country with a proportionately larger services or low technology manufacturing sector.

A second influence on innovative capabilities is the size distribution of manufacturing firms. The probability that a firm innovates (using a broad definition), performs R&D, applies for a patent, or adopts AMTs is positively correlated with firm size.

We use three indicators to capture differences in the industrial structure of EU member states. Our first indicator is the share of private sector value-added in services out of total private sector value added (services, primary sectors, industry, and manufacturing). These shares partly determine the locus and relative importance of creative innovation and innovation as a diffusion process, with the latter more prevalent in services. The second indicator is limited to manufacturing, where most technical innovation occurs. The indicator is the share of low and medium-low technology manufacturing out of total manufacturing value added. For both indicators we use value-added instead of employment or sales because value-added is the most accurate indicator of the contribution of each sector to GDP.

Our third indicator is the percentage of all manufacturing employees that work for an SME (less than 250 employees). We would prefer to use the share of value-added contributed by SMEs, but this indicator is not available. Using employment will overestimate the economic importance of SMEs because larger firms tend to use labour more productively.

3.3 International openness of the economy

The openness of an economy to trade and ideas can influence its innovative capacity in three ways: first, it conditions its competitiveness in international markets, second, it affects its capacity to absorb knowledge created by its trade partners and finally, by enabling the flow of ideas, it facilitates the access of domestic researchers to ideas discovered by their foreign counterparts (Cameron et al., 1999). We include three indicators for international openness.

Our first indicator is UNCTAD's 'Transnationality Index' for 2000. The index is the average of four indicators that measure the flow and stocks of inward FDI, value-added by foreign affiliates, and employment in foreign affiliates. The FDI component is an indicator for the openness of an economy to foreign investment. The value-added and employment component measures the impact of FDI on the domestic economy. Both components are proxies for the effect of FDI as a source of new technology embodied in equipment and of innovative organizational and management methods.

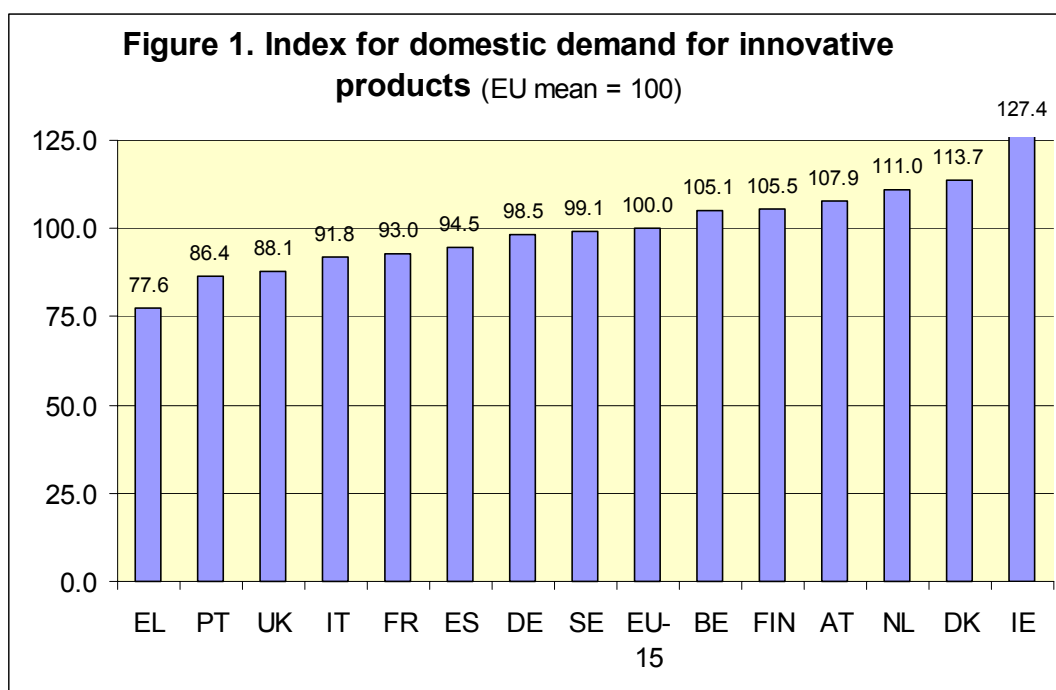
The second indicator is the importance of trade to the economy (imports plus exports divided by total GDP). This is both a measure of the level of competition faced by domestic firms, which could compel them to innovate, and inward flows of embodied innovation. As pointed out in Varsakelis (2001), the innovative effort (i.e., the R&D investment) of a country will increase with its willingness to be competitive in international markets.

The innovative capacity of an open economy will not only depend on its domestic stock of knowledge but also on that of other economies. Ideally, we would like to have a measure of the international flows of ideas to which an economy is exposed. An indicator could be the amount of international knowledge flowing to a country, which is proportional to the amount of contact between economies. Cameron et al. (1999) develop such an indicator for the

contribution of foreign R&D to the domestic knowledge stock for the UK manufacturing sectors. However, this is a complex indicator that is unavailable for other EU countries. Our third indicator is the percentage of domestic R&D that is funded by foreign sources. This is a proxy for the inflow of new ideas, albeit an unsatisfactory one, because the purpose of foreign funding of domestic R&D is often to transfer knowledge *to* the funding country, rather than the reverse.

3.4 Results for structural indicators

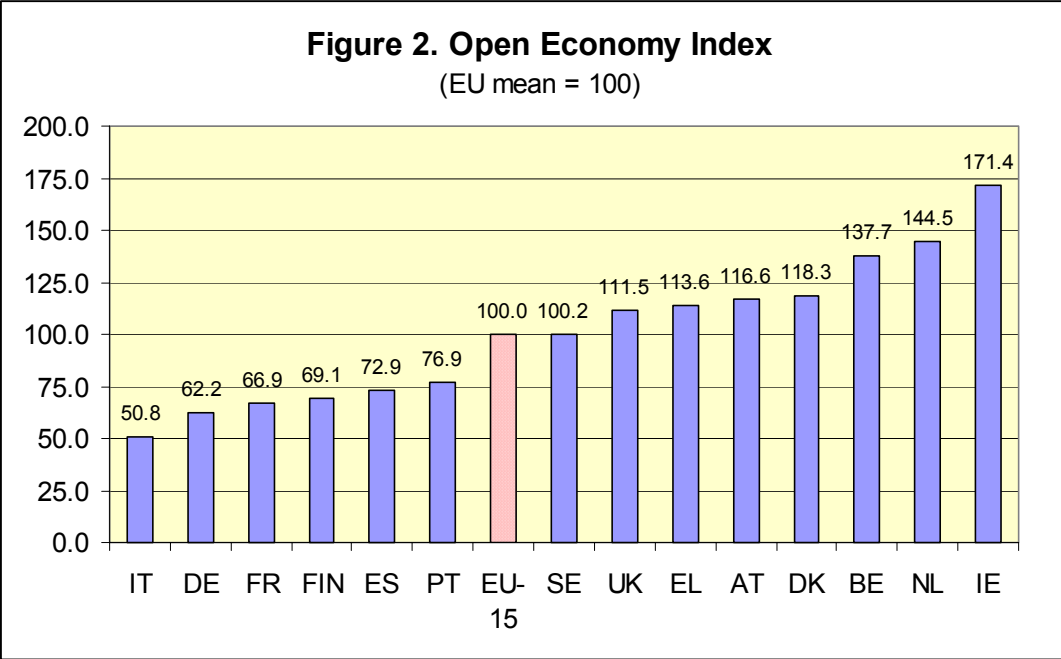
Figure 1 gives the results, by country, for the composite index for domestic demand. The index assumes that approximately three-quarters of demand for innovative products and services is due to consumer demand (based on youth share, income, and time to take-off) while one-quarter is due to business demand. Of note, the inclusion of the youth indicator in the composite demand index partly turns it into an indicator for *future* demand, while the use of data on product take-off times measures past demand.



The index for domestic demand is correlated with per capita GDP (correlation coefficient = .80, $p < .001$), but only weakly with the 2003 EIS summary innovation index (correlation coefficient = .49, $p = .077$). The demand index is also correlated with the EIS indicator for employment in high tech services and with the percentage of SMEs involved in innovation cooperation, but not with the other five key EIS indicators. The weak relationship with the summary innovation index should be apparent from Figure 1, which shows a below average score for one of Europe’s most innovative countries, Sweden, and a higher score for one of Europe’s less innovative countries, Austria. The weak relationship suggests that domestic demand is not an important driver for innovation. The most likely explanation is that innovative firms based in countries with comparatively low domestic demand, such as Sweden, can effectively adapt their products and services to sophisticated demand in their export markets. Of note, there would be cause for concern if there was a strong relationship

between domestic demand and innovation, because the demand index is below average for the four major EU economies: the UK, Italy, France, and Germany.

Figure 2 gives the results for the composite index for an open economy. The index is the average of the UNCTAD transnationality index (four measures of the role of foreign firms in the economy), economic dependence on trade (the share of imports and exports in GDP), and the share of R&D funded by foreign sources. Data are unavailable for Luxembourg. Three of the EU’s smaller economies, Ireland, the Netherlands, and Belgium have the highest scores for an open economy, while three of the EU’s largest economies, Italy, Germany and France, have the lowest scores. The results are similar when the openness index excludes the foreign R&D share, which can be high if there is little domestic innovation. The open economy index is not correlated with per capita GDP, the summary innovation index or any of the six key EIS indicators. This suggests that economic openness is neutral to innovation, although it will influence the innovation path within a national innovation system.



The poor relationship between the openness index and innovation is probably because the index measures two factors, only one of which may be related to national innovative capability. First, the index measures the size of the economy, with smaller countries such as the Netherlands, Belgium and Austria needing to trade in order to survive, due to small internal markets, while larger economies such as Italy, Germany and France have large internal markets. Second, the index measures the attractiveness of the local economy to FDI and foreign R&D. In the European context, FDI is higher in English-speaking countries, while foreign R&D can either be seeking local expertise (as with the pharmaceutical sector in the UK) or transferring basic production knowledge, as with Portugal. These factors could explain the low scores on openness for Finland and Sweden, even though these are two smaller countries with high exports, and the higher score for the large UK economy.

3.4.1 Industry structure

As shown in Table 3.2, the share of business value-added from private services is not correlated with per capita GDP, the 2003 SII, or any of the seven key EIS indicators. In contrast, the share of low-medium tech manufacturing out of all manufacturing value-added and the SME share of manufacturing employment are negatively correlated with per capita GDP, the SII, and key EIS indicators for business R&D and employment in high tech services. The share of low-medium value added is also negatively correlated with the percentage of the working age population with a tertiary education and with EPO high tech patenting.

Table 3.2 Correlation matrix for industry structure indicators¹

	Share of business value-added from private services	Share of low-medium tech manufacturing sectors in all manufacturing VA	SME share of manufacturing employment
Per capita GDP in 2002	-	-.764, p = .002	-.729, p = .005
Summary innovation index (SII)	-	-.734, p = .003	-.586, p = .035
Tertiary education rate	-	-.565, p = .035	-
Employment in high-tech services	-	-.735, p = .003	-.615, p = .025
Business R&D expenditures	-	-.610, p = .020	-.567, p = .043
EPO high tech patents/million pop.	-	-.606, p = .021	-
Percent SMEs innovating in-house	-	-	-
Venture capital supply	-	-	-
Share of sales from innovative products	-	-	-

1: Only statistically significant correlations (p < .05) shown.

The negative relationships in Table 3.2 are largely due to Portugal, Greece and Spain. These countries have a very high share of SMEs and low-medium technology sectors in total manufacturing value added (these two structural indicators are also correlated, with a correlation coefficient of 0.697, p = .008). Removing these three countries from the correlations results in no relationship between these two structural indicators and per capita GDP, the SII, or the key EIS indicators. This suggests a high share of SMEs or low-medium tech manufacturing in more developed economies does not necessarily reduce innovative capabilities. As an example, Denmark has similar values for these two indicators as Spain, but performs much better on the SII and for per capita GDP.

3.5 Cluster analysis

We experimented with a three and four cluster solution for the structural indicators. The clusters include the composite indicators for demand (DEMAND) and for an open economy (OPEN) and each of the three industry structure indicators. The best results are for a three-cluster solution. Due to missing data, Ireland and Luxembourg are not included in the cluster analysis. The strongest determinants of the cluster are DEMAND, the percentage of manufacturing value-added from low and medium-low manufacturing sectors, and the SME share of total manufacturing employment. The results are given in Table 3.3.

Cluster 1 is characterized by low openness and high economic importance of SMEs and low/medium-low technology manufacturing sectors. This cluster includes three countries that we would expect to find together, Spain, Portugal and Greece; and one anomaly, Italy. Clusters 2 and 3 both differ from cluster 1 in having a much less important role for SMEs and low/medium-low manufacturing. The main factors that differentiate cluster 2 from cluster 3 is the openness of the economy and demand, with cluster 2 having higher average scores for both. Cluster 2 includes four small economies, Denmark, the Netherlands, Austria and Belgium. We would expect Ireland to be included in this cluster, given complete data. Cluster 3 includes a greater diversity of countries, with both three large economies (the UK, France and Germany) and two small economies (Sweden and Finland).

Table 3.3 Three cluster solution for the structural indicators

	1	2	3
Description	Low openness, high role of low-medium tech sectors & SMEs	High openness, high demand, moderate role of low-medium tech sectors & SMEs	Low openness, low demand, low role of low-medium tech sectors
Countries in cluster	Greece, Spain, Italy, Portugal	Belgium, Denmark, Austria, Netherlands	Germany, Finland, France, Sweden, UK
OPEN	.20	.57	.24
DEMAND	.22	.63	.31
Private service share of total VA	.25	.31	.27
Low-medium tech share of manuf VA	.71	.39	.23
SME share of manuf employment	.90	.41	.42

Notes: All mean values for each indicator are based on rescaled indicators that vary from 0 to 1.0.

Of interest, the cluster analyses for the structural indicators do not separate the highly innovative economies of Sweden and Finland from the less innovative larger economies of France and Germany, even though Sweden and Finland rank higher on the summary innovation index than many of the other countries in cluster 3. This suggests that structural differences are not the main cause of the differences in the EIS results for these countries. Table 3.4 looks further at these issues and gives, for each cluster, the mean values for per capita GDP, the summary innovation index, and the average for each of the seven key EIS indicators.

The first cluster has the poorest results for per capita GDP, the summary innovation index, and the key EIS indicators. Cluster 3 does better on the summary innovation index and most EIS indicators than cluster 2.

Table 3.4 Mean GDP, SII and innovation values for each structural cluster

	1	2	3
Countries in cluster	Greece, Spain, Italy, Portugal	Belgium, Denmark, Austria, Netherlands	Germany, Finland, France, Sweden, UK
Per capita GDP (per cent of EU mean) in 2002	80.3%	112.5%	102.8%
Summary Innovation Index (2003)	.24	.46	.57
Tertiary education share in 2002	15.5%	24.3%	26.8%

High tech service employment share in 2002	2.2%	4.1%	4.4%
Business spending on R&D/GDP in 2001	0.4%	1.4%	2.0%
EPO high-tech patents/population	3.2	38.3	70.3
% SMEs in innovation cooperation (1998-2000)	4.3%	12.2%	13.8%
Early stage venture capital (% GDP in 2002)	0.015%	0.046%	0.062%
% sales from new to market products in 2002	19.1%	20.2%	14.0%

Notes: Differences by cluster are statistically significant ($p < .05$) for all variables except for percent sales from new to market products in 2002.

Several observations can be drawn from these analyses. First, and this is no surprise, countries dominated by SMEs and low/medium-low technology manufacturing rank poorly on innovation measures. Part of this relationship spills over into cluster 2, which has a higher share of low/medium low technology in manufacturing value added than cluster 3. This explains the lower business R&D intensity and patent rates in cluster 2 compared to cluster 3. However, there is only a small difference in the average summary innovation index of the countries in clusters 2 and 3. There are several possible explanations. The higher values for the composite indices OPEN and DEMAND for cluster 2 compared to cluster 3 could confer some benefit to innovative capabilities. Alternatively, the SMEs and low/medium-low manufacturing firms in cluster 2 countries (Belgium, Denmark, Austria and the Netherlands) could be particularly innovative.

4. Social, institutional and cultural indicators

The SCI indicators are grouped into six categories: finance, social creativity, social equity, labour market, entrepreneurial attitudes, and social capital. Table 4.1 summarizes the indicators within each of these six categories. In the following sections, we explain each indicator.

Table 4.1 Socio-cultural and institutional indicators

Categories & indicators	Source	Year
1 Finance		
1.1 Insider/outsider composite index	Block (2002) plus others	1975 – 1997
2 Receptiveness to new ideas		
2.1 Percent of tertiary students from abroad	OECD – Education at a glance 2002	Average 1996-2000
2.2 Percent of population that can converse in at least one foreign language	Standard Eurobarometer 55, p. 81 (EC, 2001a)	April-May, 2001
2.3 Attitude towards science, e.g. esteem for scientific professions	Eurobarometer Special Survey 55.2, December 2001 (Table 26)	May-June, 2001
2.4 Percent of households living in densely populated areas	EUROSTAT (Urbanization rates)	Average 1996-2001
2.5 Percent employed (25 to 64 inclusive) with creative occupations (ISCO classes 1 – 3)	Eurostat: Labour Force Survey	
3 Social equity		
3.1 Expenditure on social protection as a percentage of GDP	Eurostat: Social protection statistics	Average 1998-2000
3.2 Income equality: 1 – (total income received by the top 20% of the population/ that received by the bottom 20% of the population).	EUROSTAT – Structural indicator IV.1	Average 1995-1999
3.3 Employment participation rate: Percent of working age population (15-64 inclusive) in employment	Eurostat: Structural indicator I.1.1	Average 1997-2001
4 Labour market		
4.1 Job mobility (Percent employees with less than 2 years in their current employment)	Eurostat; Labour Force Survey	Average for two years: 1995 & 2000
4.2 Percent of employees in a trade union	EIRO	2000
5 Entrepreneurial attitudes		
5.1 Positive attitude to self-employment	Flash Eurobarometer 134 (2002)	2002
5.2 Positive attitude to starting a financially risky business	Flash barometer 83 (Sept 2000), 107 (Sept 2001), 134 (Nov 2002)	2000 - 2002
6 Social capital		
6.1 Trust: Percent of survey respondents agreeing that ‘most people can be trusted’ to the question: ‘Generally speaking, would you say that most people can be trusted or that you can’t be too careful in dealing with people?’	European Values Study Survey 1999-2000 (van Schaik, 2002)	1999-2000

4.1 Financial system

Although many economists see markets as the most efficient mechanism for allocating resources, there are clear institutional differences across countries in how firms are financed. Financial markets play a very important role in the US, whereas they are unimportant in Germany, where the highly concentrated banking system plays the most important role.

A number of studies have analyzed the relationship between the characteristics of the financial system and sectoral growth patterns (Carlin and Mayer 1999, Rajan and Zingales 1998). These results sometimes contradict the theoretical literature, which predicts an influence of the financial system on sector-specific innovation. Allen and Gale (2000) argue that financial markets succeed better than banks in promoting new industries and new technologies, whereas bank-based systems have been more successful at promoting traditional industries.

Recently, Block (2002) has defined two types of financial systems and evaluated their effect on innovation. Relative to insider or bank-based systems, outsider or market-based systems are characterized by lower bank and ownership concentration, better accounting standards, and greater stock market concentration. Block's analysis suggests that outsider systems promote higher growth rates in product-oriented and science-based sectors, whereas export-competitiveness in process-oriented sectors is positively correlated with insider systems. He uses four financial structure variables (bank concentration, a financial structure index, accounting standards and ownership concentration)⁹, to develop an insider/outsider indicator.

Using the same data as in Block (2002), we construct an *Insider/outsider composite index* to characterize financial systems. A high value for the indicator represents a market-oriented finance system, while a low value represents a bank-based system¹⁰. The UK is an outlier with a strong market based finance system, while Austria, Portugal and Spain have bank-based financial systems.

4.2 Receptivity to new ideas

Innovation derives from creative activities based on research, exploration, combining existing knowledge in new ways, and on flashes of insight and imagination. Florida (2002), in *The Rise of the Creative Class*, argues that the 'rise of human creativity' is 'the defining feature of economic life', because 'new technologies, new industries, and new wealth and all other good economic things flow from it' (p 21). Florida's main thesis is that creative individuals are

⁹ Bank concentration is measured as the ratio of the three largest banks' assets to total banking assets averaged for the period 1990-1997 (Levine et al., 2000); accounting standards are on a scale from 0 to 90 from a survey conducted by the Center of International Financial Analysis and Research in 1990 (Rajan and Zingales, 1998); financial structure is measured as the ratio of stock market capitalization and bank assets, with stock market capitalization (value of listed shares/GDP) averaged for the period 1975-1997 (Levine et al., 2000); and ownership concentration is measured as 1 minus the percentage of total stock held by the largest 20 publicly traded corporations in 1995 (La Porta et al., 1998).

¹⁰ There are some differences between our composite index and the one calculated in Block (2002). First, we use a different methodology to obtain the index. Block uses Principal Component Analysis whereas we calculate rescaled values for each indicator (see Section 2 above), then take the average. Second, we exclude non-EU countries from the computations. Third, we transform the index so that the lowest observed score, for Austria, is zero. Both the Block index and our index are highly correlated, with an R-square value of 0.85.

nurtured by social conditions that permit social diversity and openness to new ideas to thrive. These individuals, in turn, drive the innovative economy. The assumption is that socially creative societies that are more ‘open’ to new ideas will both be more willing to adopt new technologies developed elsewhere and also be more likely to develop new ideas internally.

Florida develops a creativity index that is based on two measures of innovation (patents per capita and the high technology industry share), an indicator for the percentage of the population in creative occupations, and a measure of social diversity, which is the percentage of the population that is homosexual. For the United States, the creativity index is correlated, at the city level, with other indicators for innovation.

Florida’s creativity index is not useful as a measure of the socio-economic and institutional characteristics of a national innovation system. This is partly because his creativity index includes two innovation indicators that are more appropriate as measures of the outputs of a creative society (patents and the high technology industry share), whereas we are more interested here in the conditions that shape such a society. Second, Florida’s measure of diversity is only appropriate at the city level because homosexuals are most likely to migrate to tolerant cities within their own country, rather than migrating to the most tolerant countries within the EU.

We identify several indicators that should overcome these problems with applying Florida’s approach to the national level. However, these national level indicators are not measures of social creativity, which could be estimated from the output of patents, as suggested by Florida, or other data on design registrations or measures of artistic output. Instead, the indicators used here cover either exposure to or receptiveness to new ideas, particularly from outside the country.

The first indicator is the percentage of tertiary level students (ISCED 5 & 6) that are foreign students. These students should increase local diversity, respond to tolerance, and introduce new ideas. The indicator is not perfect because it will also reflect the strengths of the public research sector and the popularity of the national language, although both of these factors should have a positive impact on attracting creative individuals that could expose the domestic population to new ideas.

The second indicator is the percentage of the adult population (age 15 and over) that can take part in a conversation in a language other than their mother tongue. A knowledge of foreign languages should increase tolerance and support the adoption and diffusion of foreign ideas and innovations.

The third indicator is a measure of the adult population’s regard for scientific professions. Survey respondents were asked which three of 10 occupations they held in the most esteem. The indicator is the sum of positive responses for two occupations: scientists and engineers. It reflects the value that the general public gives to science, a generator of new ideas, and also its trust in science.

The fourth indicator is the percentage of households living in densely populated areas, defined as areas with a population density greater than 500 inhabitants per square kilometer and with 50,000 or more inhabitants. Several studies have found that larger cities are more innovative than smaller cities (Carlino, 2001; Therrien, 2003). This could partly be due to the settlement

patterns of creative individuals, who could prefer larger and more culturally diverse cities. Larger cities could also expose the population to a greater variety of ideas and innovations.

The final indicator is an attempt to match Florida's indicator for the percentage of the population in creative occupations and possibly comes closest to measuring social creativity at the national level. Florida's indicator is divided into a 'super creative core' and 'creative professionals', and is based on detailed occupational data. We are unable to match this level of detail for Europe. Our alternative is based on the percentage of the employed population (25 to 64 inclusive) that work in ISCO classes 1 to 3. This includes legislators, senior officials and managers (class 1), professionals (class 2), and technical and associate professionals (class 3)¹¹.

4.3 Social equity

In advanced industrial societies, there are marked differences in social equity, such as income, wealth and education, among the population. These differences could influence innovative capability, although the direction of the effect is subject to debate.

A socially inclusive society, with high rates of after-tax income equality and high educational levels, could support innovation through three channels: increasing the disposable income of much of the population, thereby creating sophisticated demand; increasing the pool of individuals with the capital and education to invest in risk taking innovative projects, and increasing the pool of highly-trained scientists and engineers.

Conversely, inequality could also increase innovation. High financial rewards for successful innovation and entrepreneurship could encourage individuals to invest in the skills and abilities that lead to high financial rewards. If the distribution of income is less skewed, then the rewards for investing and saving are smaller, as well as the incentives to do so. On the other hand, inequality may be harmful for innovation, as low-income individuals may not have the resources to make the necessary investments to be able to access high-wage jobs. This reduces both the human capital stock of the economy and the purchasing power of much of the population. For the same reasons, social protection spending may either good or bad for innovation, as its objective is to achieve income equality.

In the real world we find examples that support both theories. The United States is the classic example of an innovative economy with a highly skewed income distribution. Japan, Taiwan, Sweden and Finland are examples of countries with high innovative capabilities and high social equity. Nevertheless, these examples do not prove that social equity either promotes or hinders innovation – other factors within each society could be the main determinants of national innovative capabilities.

In a theoretical framework, Rillaers (2001) has shown that under some conditions the introduction of unemployment benefits increases investment in education, which could improve innovative capabilities. Several cross-country studies (Barro 1989, Perotti 1996, Sala-i-Martin 1992) show that social security expenditures have a positive effect on GDP growth, which could be due, in part, to increased innovation. In a more recent contribution,

¹¹ Excluded job categories cover clerks, service workers, agricultural and fishery workers, craft and related occupations, plant and machine operators, elementary occupations, and the armed forces.

Belletini and Ceroni (2000), using both cross country and panel data, find that social security spending has a positive effect on economic growth through the positive influence of social security on human capital investment. This further suggests that expenditure on social protection may have an indirect effect on innovation.

We include three indicators for social equity: the percentage of GDP spent on social protection, an indicator for income equality, and the percentage of the working age population that is employed. As with social creativity, we construct a composite index for social equity.

4.4 Labour market system

The two labour market indicators consist of the percentage of employees that belong to a trade union and a proxy for occupational mobility.

There are two opposing views of the effect of union membership on innovation. Research from a neo-classical economics perspective suggests that union membership reduces flexibility, creating a hostile environment for change, including the types of changes that are required to successfully innovate (Rutherford, 2003). In addition to hostility to change, high union wages could also decrease the profits available for investment in R&D. In this case, high wages act as a tax that raises the costs of sunk investment, thereby reducing the amount that firms will be willing to invest (Menezes-Filho et al., 1998). The opposite view is that free markets, due to an imbalance in the power of labour and capital, will lead to low wages and a resulting lack of investment in productivity-enhancing innovation. High union wages therefore create an incentive for firms to adopt new technology or to seek more profitable markets through product innovation (Kleinknecht, 1998). In addition, the social aspects of unionization, rather than creating a hostile environment to change, could help to encourage information flows between management and workers, improving the efficiency of process innovation.

The empirical evidence on the relationship between unionization and innovation is mixed (Rutherford, 2003), partly because the economic role of unions differs between countries. In the United States and the UK, unions are mostly concerned with wages, while in Germany and Scandinavia unions play a much larger economic role, including participation on management boards. This may partly explain different results in the empirical and theoretical literature. For example, the model developed by Menezes-Filho et al (1998) predicts that unionization will only reduce investment in R&D when a high percentage of the population is unionized and when unions only bargain over wages. Other research finds that productivity-enhancing innovations are adopted more quickly at unionized than non-unionized firms (Eaton and Voos, 1992).

High levels of job mobility are thought to favour the flow of knowledge and ideas, thus fostering innovation. The evidence is largely based on case studies, such as high rates of job mobility in Silicon Valley (Carnoy et al, 1997), which could have led to the rapid diffusion of knowledge between firms. Rutherford (2003) argues that high job mobility is a characteristic of liberal market economies such as the United States and the UK. In these countries, firms provide little training, with advanced skills obtained by employees at their own expense, reducing any loyalty felt by employees for their employer.

We lack a good measure of job mobility for Europe, which would optimally be defined as the number of jobs held over a defined period of time, such as five or ten years. Our alternative proxy is the percentage of the workforce that has held their current job for less than two years. The disadvantage with this indicator is that it also includes new entrants into the labour force.

4.5 Entrepreneurial attitudes

Innovation is inherently risky. A widespread acceptance throughout society of risk taking (or an entrepreneurial attitude) should increase the number of attempts at developing innovative products and services. We use two indicators for entrepreneurial attitudes.

The first indicator is the preference of a random population sample of adults (over 15) to being an employee versus being self-employed. This measures the personal attitude towards entrepreneurship. However, there are serious limitations to this indicator. We have no information on the form of self-employment envisaged by the respondent. The respondent could be thinking of establishing an innovative start-up, or simply establishing a café, restaurant, store, or small hotel. The second indicator is the percentage of a random population sample of adults (over 15) that disagreed with the statement “one should not start a business if there is a risk it might fail”.

We also considered two indicators for the time and cost of new business registration, available from DG Enterprises *Benchmarking Enterprise Policy* (EC, 2002b). We decided not to use these indicators because they were likely to be far less important as barriers to setting up a firm as attitudes. For example, the longest time required in the EU-15 to set up a business is only 7 days.

4.6 Social capital

We only have one indicator for social capital: the level of trust for others among a random survey of adult respondents. The OECD defines social capital as ‘networks together with shared norms, values and understanding that facilitate cooperation within or among groups’ (OECD, 2001: 41). The link between social capital and innovation derives from the evolution in the concept of innovation over the last decades. Whereas in the 1950s the innovation process was an activity carried out in isolation, nowadays it is considered as the result of a process involving different actors that have to interact socially. As a consequence, innovation can no longer be solely explained by the combination of tangible forms of capital, but also requires the combination of intangible forms of capital, with social capital among them (Landry et al., 2000).

Social capital could contribute to innovation by reducing transaction costs between firms, as well as information, and enforcement costs (Barney and Hansen, 1994). Although social capital can take different forms (trust, norms and networks), most of studies that include a measure of social capital use trust in people (Knack and Keefer, 1997; Whiteley, 1997). According to Knack and Keefer (1997, p. 1252): “Low trust can also discourage innovation. If entrepreneurs must devote more time to monitoring possible malfeasance by partners, employees and suppliers, they have less time to devote to innovation in new products or processes.”

Using survey data at the firm level, Landry et al. (2000) fail to find a positive effect of the level of trust on the firm's decision to innovate, but other measures of social capital used in their study, such as network assets and relational assets, are shown to increase the firm's likelihood to innovate. An important limitation of the study, however, is that it cannot link trust to innovation strategies among firms that already innovate. At the national level, Knack and Keefer (1997) find a positive and significant correlation between the level of trust in people and rates of economic growth, although its robustness has shown to be limited by Beugelsdijk et al. (2001). At the regional level, Putnam et al. (1993) find a relationship between social capital and the economic performance of Italian regions¹². De Clercq and Dakhli (2003) find weak evidence for a positive relationship between two measures of social capital, trust and participation in networks, and several measures of innovation, but much of the relationship is lost after controlling for social equity.

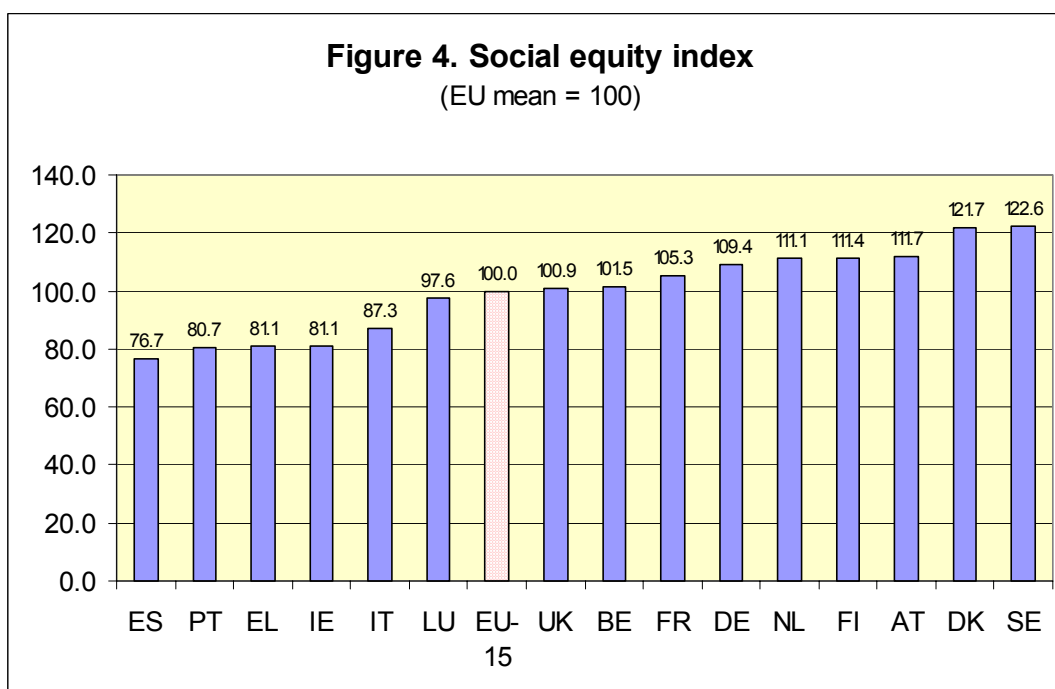
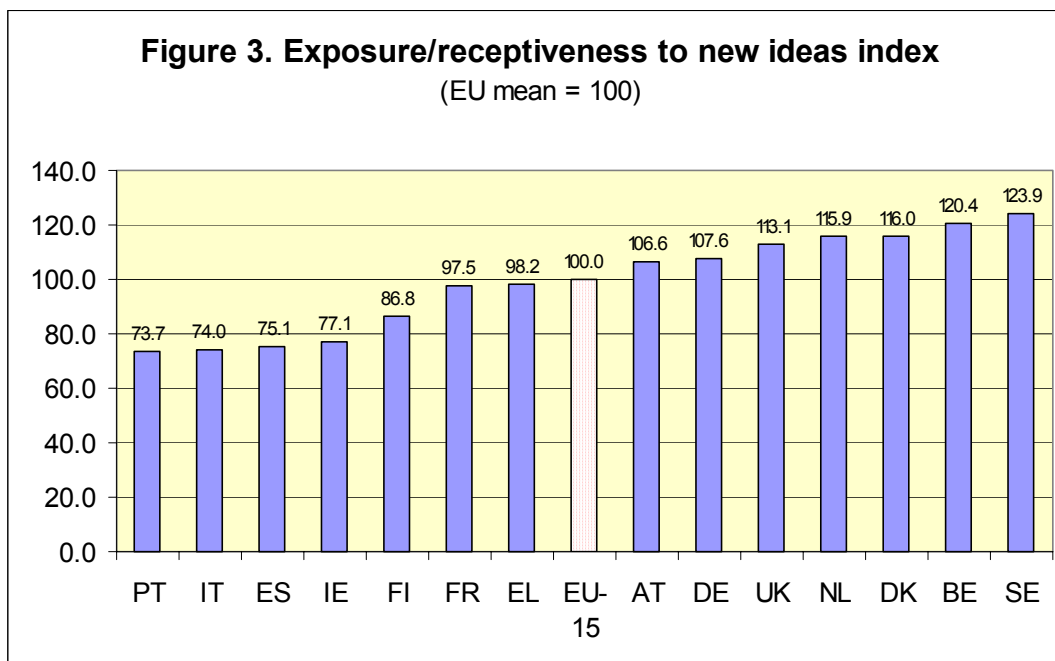
What we would like to measure is the level of social capital existing in the business community, since this is likely to have a more direct impact on the innovation process. Unfortunately, data on social capital for the EU is limited to national population data on interpersonal trust. We have no other EU-wide indicators for aspects of social capital such as networks.

4.7 Results for SCI indicators

We construct a single composite index for exposure to or receptiveness to new ideas (EXP-RECEPT) using five indicators. Of note, our primary goal here is to determine if a variation on Richard Florida's approach for US cities can be applied at the national level in Europe. The results are given in Figure 3. The lowest levels of EXP-RECEPT are in Portugal, Italy, Spain and Ireland, while the highest levels are in Belgium and Sweden.

The composite index for social equity (EQUITY) is given in Figure 4. The lowest values are found in Spain, Portugal, Greece and Ireland with the highest levels in Denmark and Sweden. EXP-RECEPT and EQUITY are correlated with each other (coefficient of 0.61, $p < .05$), with the summary innovation index (coefficients of 0.52 and 0.63 respectively), and with business R&D (0.58 and 0.66 respectively). EQUITY is also positively correlated with EPO high tech patenting, the percentage of SMEs involved in innovation cooperation, and the supply of early stage venture capital. However, EQUITY is not, as we expected, correlated with the supply of S&E graduates, tertiary education, or with DEMAND. Consequently, there is no evidence to suggest that the role of greater equity in promoting innovation is due to a better educated population or to higher disposable incomes, leading to more sophisticated domestic consumer demand.

¹² Contrary to Knack and Keefer (1997), Putnam et al. (1993) and other empirical studies that have used data on interpersonal trust and other general measures of social capital, Landry et al (2000) use indicators that specifically refer to the business environment. As such, they are better in assessing the level of social capital that is more likely to have an impact on innovation.

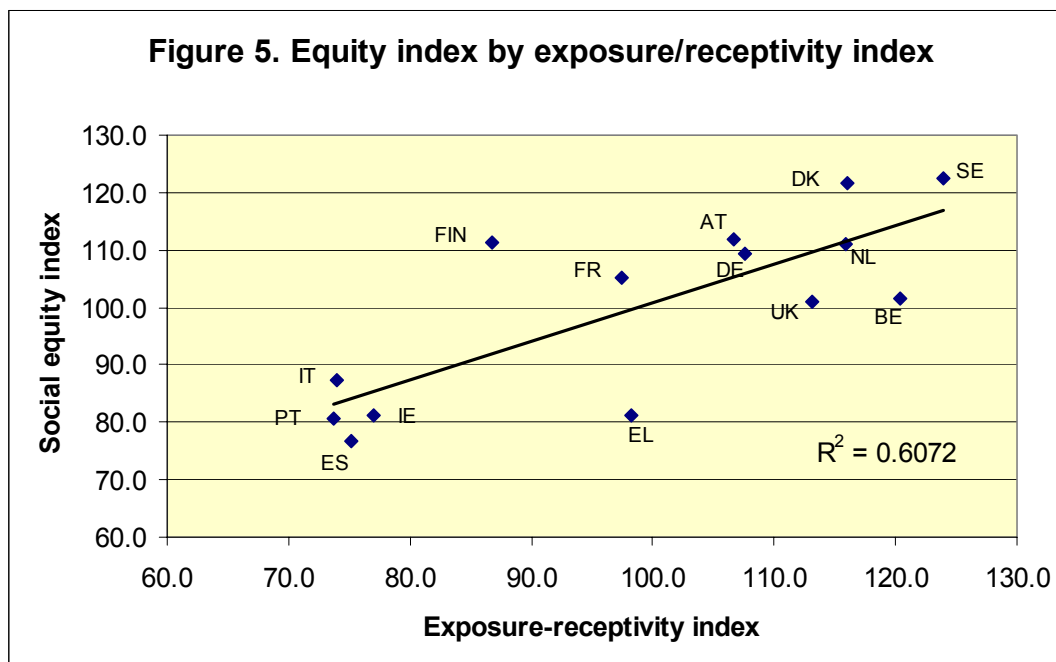


Graphing EXP-RECEPT against EQUITY, as shown in Figure 5, shows that the EU Member States divide into two clusters. In the bottom left-hand corner are four countries (Portugal, Ireland, Italy, Spain) that have low scores for both exposure/receptiveness and equity. The remaining EU countries, with the exception of Greece, are in the top right-hand corner with moderate to high levels of equity but with a wide range of values for EXP-RECEPT.

Several of the SCI indicators appear to add little to our understanding of innovation, as shown by a limited number of correlations with variables of interest. For example, the finance

indicator is not correlated with the SII or with any of the seven key EIS indicators. The indicator for job mobility is only positively correlated with tertiary education (.622, $p = .018$).

There is a positive correlation between the trust indicator (SCI6.1) and the summary innovation index (.731, $p = .002$) and with all but one of the key EIS indicators (new-to-market sales). Trade union membership is also positively correlated with the SII (.611, $p = .016$) and with all but two key EIS indicators (tertiary education and new-to-market sales). Conversely, the entrepreneurship index is negatively correlated with the summary innovation index (-.775, $p = .001$) and with all but one of the key EIS indicators (new-to-market sales).



4.8 Cluster analyses

We experimented with three, four and five cluster solutions. The four-cluster solution shown in Table 4.2 gives the greatest level of differentiation. The cluster includes the composite indices EXP-RECEPT, EQUITY and ENTREPRENEUR, the finance indicator (SCI1.1), trade union membership (SCI4.2), and trust (SC6.1), but excludes job mobility (SC4.1) because it added little additional information. Due to missing data, Luxembourg is not included. The results place Greece and Portugal in difference clusters. The three and five cluster solutions similarly place Greece and Portugal into different clusters.

The first cluster includes four countries, all of which are in the bottom left quadrant of Figure 5. All have below average values for EXP-RECEPT, EQUITY, trust, and union membership. The main distinguishing feature of this group is a highly positive attitude to entrepreneurship. The second cluster consists of countries that perform reasonably well on EXP-RECEPT (including Greece) but perform very poorly on entrepreneurship. The third cluster includes two countries, the UK and France, which are rarely linked together but which emphasize market-based solutions. This is shown by the finance indicator, which is more market based in France and the UK than in any other EU country, the low rate of union membership and trust, and the second-highest value for entrepreneurship. The final cluster includes four high social

equity countries, Denmark, Finland, Sweden and the Netherlands. The defining characteristic of this cluster is the high values for equity, union membership, and trust, plus high values for receptiveness to new ideas.

Table 4.2 Four cluster solution for the SCI indicators

	1	2	3	4
Description	Low equity high entrepreneurship	Middling non-entrepreneurs	Market solutions	Equitable societies
Countries in cluster	Spain, Italy, Portugal, Ireland	Austria, Belgium, Germany, Greece	France, UK	Denmark, Finland, Netherlands, Sweden
EQUITY	.14	.51	.59	.87
EXP-RECEPT	.11	.63	.67	.81
Finance	.30	.16	.75	.26
Union membership	.28	.43	.13	.75
Entrepreneur	.68	.11	.56	.17
Trust	.27	.21	.15	.92

There is no significant difference in the average per capita GDP among the four clusters. However, there is a significant difference in the SII and for five of the seven EIS indicators (the exceptions are tertiary education and new-to-market sales). The results are given in Table 4.3. In general, the value of each indicator improves from cluster 1 through to cluster 4, with the exception of new-to-market sales, where the direction is reversed. This is probably because markets are more sophisticated in cluster 4 than in cluster 1, with fewer unfamiliar market introductions.

Table 4.3 Mean GDP, SII and innovation values for each SCI cluster

	1	2	3	4
	Spain, Italy, Portugal, Ireland	Austria, Belgium, Germany, Greece	France, UK	Denmark, Finland, Netherlands, Sweden
Per capita GDP (per cent of EU mean) in 2002	92.5	97.5	101.5	109.3
Summary Innovation Index (2003)	.31	.38	.47	.63
Tertiary education share in 2002	17.4%	21.2%	26.5%	27.8%
High tech service employment share in 2002	2.8%	3.1%	4.3%	4.8%
Business spending on R&D/GDP in 2001	0.6%	1.2%	1.3%	2.1%
EPO high-tech patents/population in 2001	10.4	23.3	33.0	87.0
% SMEs in innovation cooperation (1998-2000)	4.0%	8.8%	11.0%	16.4%
Early stage venture capital (% GDP in 2002)	0.017%	0.029%	0.041%	0.077%
% sales from new to market products in 2002	20.2%	17.6%	8.3%	7.7%

Notes: Differences by cluster are statistically significant ($p < .05$) for all variables except for GDP, percent sales from new to market products in 2002.

5. Conclusions: Linking Structural and SCI Indicators

Our first research question is to identify NIS indicators that might influence innovation capabilities, while our second question is to see if it is possible to identify clusters of similar National Innovation Systems.

5.1 NIS indicators and innovation

The correlation analyses between the structural and SCI indicators on the one hand and the SII and the key EIS indicators on the other hand show which indicators *might* be linked to innovative capabilities, although a simple correlation is not causation. Another limitation is that the correlations are based on only a small number of observations (countries). Table 5.1 summarizes the results, ordered from large negative effects on innovation to a large positive effect.

Table 5.1 Correlation between NIS indicators and innovation

NIS indicator	Correlation with innovation (SII plus 7 key EIS indicators)
SME employment share	Large, negative
Low/medium-low tech value-added share	Large, negative
Positive entrepreneurial attitude	Large, negative
Openness of the economy	No correlation
Private services share	No correlation
Job mobility	No correlation
Market based financial system	No correlation
Domestic demand for innovative products	Weak, positive
Receptivity to new ideas	Weak, positive
Social equity	Large, positive
Trust	Large, positive
Union membership	Large, positive

These results conflict with common opinion, which stresses the need for greater sophisticated consumer demand (only a weakly positive effect in Europe), a market based financial system (no effect), and a positive attitude to entrepreneurship (negative effect). Our version of Florida's work shows only a weak positive correlation between innovation and receptivity to new ideas. The strongest correlations with innovative capabilities are for measures of social equity and social capital.

Based on the simple correlations in this study and the restricted data set, we cannot conclude that these results are definitive. As an example, economic openness could have a role, but the range in this variable within Europe may not be large enough for this effect to be detectable. An alternative explanation for some of these results is that our indicator is a poor proxy for what we would like to measure. An example is our indicator for entrepreneurship. The most robust conclusions that can be drawn from Table 5.1 is that SMEs and low/medium-low

manufacturing are not sources of innovative strength, and that social equity does not hinder innovation.

5.2 Clusters of National Innovation Systems

The cluster analyses for the structural and SCI indicators give dissimilar results, although there are some similarities. The following countries are grouped together in both analyses: Spain Italy and Portugal; Austria and Belgium; France and the UK; and Sweden and Finland. We combine both the structural and SCI indicators in one four-cluster solution, as shown in Table 5.2. Ireland and Luxembourg are not included in this solution, due to a lack of data for several structural indicators. We define each cluster as follows.

Table 5.2 Four cluster solution for the Structural and SCI indicators

	1	2	3	4
Description	Low tech SMEs entrepreneurs	Middling non-entrepreneurs	Large market economies	Equitable societies
Countries in cluster	Greece, Spain, Italy, Portugal	Germany, Austria, Belgium	France, UK	Denmark, Finland, Netherlands, Sweden
OPEN	.20	.37	.26	.46
DEMAND	.22	.53	.17	.53
Private services	.25	.28	.40	.24
Low/medium tech share	.71	.25	.30	.33
SME share	.90	.26	.47	.51
EQUITY	.13	.64	.59	.87
EXP-RECEPT	.25	.65	.67	.81
Finance	.20	.20	.75	.26
Union membership	.24	.47	.13	.75
Entrepreneurship	.52	.03	.56	.17
Trust	.19	.29	.15	.92
<i>Summary Innovation index</i>	.24	.44	.47	.60
Per capita GDP (% EU mean)	<i>80.3%</i>	<i>108.0%</i>	<i>101.5%</i>	<i>109.3%</i>

Notes: The highest values for each indicator are highlighted in bold while the lowest values are given in italics.

The first cluster includes four countries with very high SME shares, a focus on low/medium-low manufacturing, and high scores for entrepreneurship (with the exception of Portugal). The fourth cluster includes the ‘Equitable societies’ of the three Nordic countries plus the Netherlands. These countries have high scores on equity, receptiveness to new ideas, union membership, and trust. They do well on consumer demand, but this is partly because the analyses do not include Ireland, which is the demand leader. Germany, Austria and Belgium form a cluster with average scores for many indicators but with a remarkably low score for entrepreneurship. The last cluster includes the two large economies of the UK and France, with the highest values for private services, non-bank finance, and entrepreneurship, but with low union membership and trust.

The last two rows of Table 5.2 give the average 2003 SII and per capita GDP in each cluster. The innovation index is lowest in the cluster of ‘low-tech SME entrepreneurs’ and highest in the equitable societies. Per capita GDP is lowest in the ‘low-tech SME entrepreneurs’, but otherwise there is no significant difference among the three remaining clusters. There are statistically significant differences between the clusters for six of the seven key EIS indicators, with the exception being no difference for new-to-market products. As in Table 4.3, the cluster of low-tech SME countries has the lowest performance on all EIS indicators (except new to market product sales), while the cluster of equitable societies has the highest performance.

The cluster results raise a few simple questions for policy. Basically, which structural and SCI conditions might play a role in improving the low innovative capabilities of the four countries in the low-tech SME cluster? Table 5.2 show that demand, private services, market finance, union membership, entrepreneurship and trust probably do not play a very important role, as the results for this cluster overlap with more innovative clusters. The performance of the low tech SME group is comparatively good for entrepreneurship, which could open opportunities for the future, if combined with access to finance and business support.

In contrast, the scores for the SME share of manufacturing employment and for the share of low/medium-low sectors in manufacturing value added are substantially higher in this cluster than in any other cluster, while this cluster has the lowest scores for social equity and receptiveness to new ideas. The results for the low/medium-low share of manufacturing value added are not surprising, since these sectors are the least innovative and have the lowest value added. Some of the same factors may help to explain the link between a dominance of SMEs and low innovation levels. SMEs in these sectors both use labour less productively and are less likely to have the financial resources to rapidly adopt innovations or to invest in innovation. A shift from low to medium-high technology sectors and to a greater share of large firms in economic output requires deep structural changes, which will require long-term policies to address. At 45.4%, Denmark has the highest share of manufacturing employment in SMEs among the more innovative economies. Perhaps countries such as Portugal, Greece and Spain can learn something from Denmark’s experience.

There is a strong correlation between equity and innovation and the low-tech SME countries lag far behind the three other clusters on this indicator. Nevertheless, it is difficult to know if equity plays a direct role in innovation and per capita GDP, or if high levels of equity are a result of high GDP, or if the relationship is only an artifact. Regardless of the explanation, high equity clearly does not interfere with either high per capita GDP or with high innovative capabilities, as noted above.

As a final comment, the cluster analyses for the SCI indicators alone assigns Portugal to a group that includes Ireland, Spain and Italy, and Greece to a group that includes Austria, Belgium and Germany. In so far as each cluster shares similar socio-cultural and institutional systems, this suggests that trans-national policy learning may work better between Portugal and Ireland and Spain, while Greece may have more to learn from Belgium, Austria and Germany.

6. References

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Annex 1

Table A1. The use of Structural and NIS indicators by other European Commission documents

Indicator	Other EC use
ST 2.3 SME share in manufacturing employment	1) Business in Europe, Statistical Pocketbook, 2) Enterprises in Europe – does size matter?; 3) Statistics in Focus, Theme 4-39/2002
SC 3.1 Expenditure on social protection	1) The social situation in the European Union 2002; 2) Social Protection in Europe, 2001; 3) Statistics in Focus.
SC 3.2 Inequality of income distribution	1) The social situation in the European Union 2002; 2) Joint Report on Social Inclusion, 2001
SC 4.1 Job mobility	1) CEC, Commission’s action plan for skills and mobility, COM(2002)72, Brussels, February 13, 2002
SC 5.1 Preference for self-employment	1) 2002 Enterprise Policy Scoreboard

Table A2. Original values of the structural and SCI indicators

STRUCTURAL	Number	BE	DK	DE	EL	ES	FR	IE	IT	LU	NL	AT	PT	FIN	SE	UK
Demand																
GDP per capita in PPS	ST1.1	108	117	105	66	82	101	115	103		114	111	70	102	104	102
young/old ratio	ST1.2	2.3	2.5	2.2	2.3	2.4	2.6	4.2	2.0	2.7	2.9	2.4	2.5	2.6	2.2	2.5
Time to takeoff (years)	ST1.3	5.1	3.8	6.4	9.0	7.1	7.4	4.8	6.7		5.4	5.9	9.3	4.6	4.3	8.5
capital investment	ST1.4	19.1	18.4	19.4	17.9	20.7	16.1	19.4	16.7	17.9	18.9	21.9	22.9	16.9	13.9	15.7
Industry structure																
private services share	ST2.1	48.9	45.4	47.3	51.0	46.6	48.8		49.5	65.1	48.2	46.3	42.3	42.5	44.5	49.4
Low-medium-low manuf VA share	ST2.2	58.0	62.6	48.2	84.3	66.5	59.4		65.6	80.8	63.2	65.1	78.6	61.8	53.6	58.8
Medium-high high tech manuf VA share		42.0	37.4	51.8	15.7	33.5	40.6		34.4	19.2	36.8	34.9	21.4	38.2	46.4	41.2
SME share manuf employment	ST2.3	36.2	45.4	30.7	57.5	49.6	38.7		50.9		37.3	18.2	57.8	34.8	35.3	34.7
Large firm manuf employment		63.8	54.6	69.3	42.5	50.4	61.3		49.1		62.7	81.8	42.2	65.2	64.7	65.3
Open economy																
Transnationality index	ST3.1		36.4	19.0	8.0	17.0	11.0	47.4	6.0		33.7	15.0	12.5	15.5	34.5	19.0
Trade share of GDP	ST3.2	82.5	39.6	30.8	24.6	28.8	26.1	80.6	25.3		67.3	47.4	35.6	35.5	41.6	28.0
Foreign R&D	ST3.3	7.2	8.0	2.2	21.8	6.3	7.7	8.9	5.7		10.3	14.9	7.8	4.5	3.5	15.9
SOCIO-CULTURAL-INSTITUTIONAL																
Finance																
FINANCE insider/outsider	SCI1.1	-0.19	-0.18	-0.03	-0.28	-0.07	0.03		-0.05		-0.09	-0.31	-0.29	-0.16	-0.09	0.38
Receptiveness to new ideas																
Percent students from abroad	SCI2.1	10.9		9.1		2.2	6.8		1.4		2.9	11.6		2.1	7.4	11.0
Languages	SCI2.2	61.0	85.0	53.0	44.0	32.0	47.0	33.0	46.0	97.0	87.0	61.0	33.0	58.0	81.0	27.0
attitude towards science	SCI2.3	80.0	78.8	69.3	78.0	79.5	81.7	47.2	73.5	82.0	79.2	52.7	61.6	71.0	79.3	77.2
Urban households	SCI2.4	57.2	36.7	52.3	66.8	50.1	45.3	38.0	47.0	30.2	64.4	41.7	42.9			63.8
Creative occupations (25-64 yrs)	SCI2.5	28.5	37.0	29.2	20.2	20.8	27.0	30.5	19.8		40.0	25.4	18.2	32.7	37.0	32.0
Social equity																
% GDP spent on social protection	SCI3.1	27.2	29.6	29.5	25.4	20.3	30.1	14.8	25.2	21.5	27.9	28.6	22.5	26.4	32.9	26.7
Income inequality ratio	SCI3.2	4.2	3.1	3.9	6.4	6.0	4.4	5.1	5.4	3.9	3.9	3.7	6.8	3.2	3.2	5.1
employment participation rate	ST1.3	58.8	75.7	64.5	55.4	53.6	61.1	62.5	52.9	61.2	71.3	68.2	67.2	66.1	71.7	71.0
Labour market																
job mobility	SCI4.1	20.4	34.3	25.3	15.5	33.3	23.6	29.5	16.3	19.2	26.7		21.6	26.5	23.8	30.2
Trade union membership	SCI4.2	69.2	87.5	29.7	32.5	15	9.1	44.5	35.4	50	27	39.8	30	79	79	29
Entrepreneurship																
Preference for self-employment	SCI5.1	34.0	37.0	35.0	48.0	56.0	42.0	61.0	57.0	37.0	30.0	35.0	71.0	26.0	32.0	48.0
Do not start a business if risk of failure	SCI5.2	53.0	45.0	56.0	50.0	46.0	43.7	34.3	47.3	56.3	49.3	55.3	54.7	46.7	52.3	39.3
Social capital																
trust	SCI6.1	29.3	66.5	34.8	19.1	38.5	22.2	35.2	32.6	25.9	59.7	33.9	21.4	58.0	66.3	29.8

Table A3. Rescaled indicators (used in cluster analyses)

		BE	DK	DE	EL	ES	FR	IE	IT	LU	NL	AT	PT	FIN	SE	UK
STRUCTURAL INDICATORS																
GDP per capita in PPS	ST1.1	0.35	0.41	0.32	0.00	0.14	0.29	0.40	0.30	1.00	0.39	0.37	0.04	0.30	0.31	0.29
young/old pop	ST1.2	0.11	0.22	0.06	0.12	0.19	0.24	1.00	0.00	0.28	0.39	0.18	0.22	0.25	0.06	0.23
Time to takeoff	ST1.3	0.76	1.00	0.53	0.05	0.40	0.35	0.82	0.47		0.71	0.62	0.00	0.85	0.91	0.15
Capital investment	ST1.4	0.58	0.49	0.60	0.44	0.75	0.25	0.61	0.31	0.44	0.56	0.88	1.00	0.33	0.00	0.20
DEMAND INDEX		0.53	0.68	0.40	0.00	0.39	0.23	1.00	0.21	0.76	0.64	0.65	0.29	0.50	0.30	0.11
private services share	ST2.1	0.38	0.33	0.27	0.42	0.20	0.41		0.31	1.00	0.36	0.18	0.08	0.00	0.26	0.38
Low-medium-low manuf employment share	ST2.2	0.27	0.40	0.00	1.00	0.51	0.31		0.48	0.90	0.41	0.47	0.84	0.38	0.15	0.29
SME share	ST2.3	0.45	0.69	0.32	0.99	0.79	0.52		0.83		0.48	0.00	1.00	0.42	0.43	0.42
Transnationality	ST.31		0.73	0.31	0.05	0.27	0.12	1.00	0.00		0.67	0.22	0.16	0.23	0.69	0.31
Trade openness	ST3.2	1.00	0.26	0.11	0.00	0.07	0.03	0.97	0.01	1.00	0.74	0.39	0.19	0.19	0.29	0.06
Foreign R&D	ST3.3	0.26	0.30	0.00	1.00	0.21	0.28	0.34	0.18		0.41	0.65	0.29	0.12	0.07	0.70
OPEN INDEX		0.50	0.52	0.11	0.40	0.17	0.11	1.00	0.00		0.77	0.50	0.21	0.16	0.40	0.41
SCI INDICATORS																
FINANCE insider/outsider	SCI1.1	0.18	0.19	0.41	0.04	0.35	0.49	0.45	0.38	0.45	0.32	0.00	0.03	0.22	0.33	1.00
Percent students from abroad	SCI2.1	0.93		0.75		0.08	0.53		0.00		0.14	1.00		0.06	0.58	0.94
Languages	SCI2.2	0.49	0.83	0.37	0.24	0.07	0.29	0.09	0.27	1.00	0.86	0.49	0.09	0.44	0.77	0.00
attitude towards science	SCI2.3	0.94	0.91	0.64	0.89	0.93	0.99	0.00	0.76	1.00	0.92	0.16	0.41	0.68	0.92	0.86
Urban households	SCI2.4	0.74	0.18	0.60	1.00	0.54	0.41	0.21	0.46	0.00	0.93	0.32	0.35			0.92
Creative occupations (25-64 yrs)	SCI2.5	0.47	0.86	0.50	0.09	0.12	0.40	0.56	0.07		1.00	0.33	0.00	0.67	0.86	0.63
RECEPTIVENESS INDEX		0.88	0.84	0.63	0.60	0.24	0.55	0.01	0.18		0.98	0.43	0.00	0.44	1.00	0.80
% GDP spent on social protection	SCI3.1	0.69	0.82	0.81	0.58	0.30	0.85	0.00	0.57	0.37	0.73	0.77	0.42	0.64	1.00	0.66
Income inequality ratio	SCI3.2	0.70	1.00	0.77	0.10	0.21	0.65	0.47	0.39	0.78	0.78	0.82	0.00	0.96	0.95	0.47
Employment participation rate	SCI3.3	0.26	1.00	0.51	0.11	0.03	0.36	0.42	0.00	0.36	0.81	0.67	0.63	0.58	0.83	0.79
EQUITY INDEX		0.48	1.00	0.68	0.11	0.00	0.58	0.15	0.18	0.42	0.77	0.75	0.22	0.72	0.98	0.60
Job mobility	SCI4.1	0.26	1.00	0.52	0.00	0.95	0.43	0.74	0.04	0.20	0.60		0.32	0.59	0.44	0.78
Trade union membership	SCI4.2	0.77	1.00	0.26	0.30	0.08	0.00	0.45	0.34	0.52	0.23	0.39	0.27	0.89	0.89	0.25
Self employment	SCI5.1	0.18	0.24	0.20	0.49	0.67	0.36	0.78	0.69	0.24	0.09	0.20	1.00	0.00	0.13	0.49
Risky business	SCI5.2	0.15	0.51	0.01	0.29	0.47	0.57	1.00	0.41	0.00	0.32	0.05	0.07	0.44	0.18	0.77
Entrepreneurship INDEX		0.07	0.35	0.00	0.36	0.59	0.46	1.00	0.57	0.02	0.12	0.02	0.55	0.14	0.06	0.67
Trust	SCI6.1	0.22	1.00	0.33	0.00	0.41	0.07	0.34	0.28	0.14	0.86	0.31	0.05	0.82	1.00	0.23